Section 13

ASSESSMENT OF GULF OF ALASKA ATKA MACKEREL

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EXECUTIVE SUMMARY

Relative to the November 2002 SAFE report, the following substantive changes have been made in the current draft of the Atka mackerel chapter:

Changes in the Input Data

1. Catch data are updated.

2. Length and age data from the 2003 survey are discussed.

Changes in the Assessment Methodology

There are no changes in the assessment methodology

Changes in Assessment Results

There are no changes in assessment results

Response to SSC comments

There were no SSC comments pertaining to the Atka mackerel assessment from the December 2002 SSC minutes.

There were no SSC comments pertaining to assessments in general from the December 2002 SSC minutes.

In this assessment the following issues are highlighted:

- Observations of adult Atka mackerel in the Western and Central Gulf of Alaska
- Rationale for maintaining separate Bering Sea/Aleutian Islands and Gulf of Alaska Atka mackerel assessments is provided.
- There is no reliable estimate of current biomass from the Gulf of Alaska bottom trawl survey. Using Tier 6 criteria, the overfishing level is set equal to the average catch from 1978-95, which equals 6,200 mt.
- Given that:

    1. there is no reliable estimate of current biomass,
    2. Leslie estimates of historic local population sizes suggest that abundance had declined significantly in localized areas from 1992-94, and
    3. the species has exhibited vulnerability to fishing pressure in the past,

    it is recommended that the ABC for Atka mackerel in the GOA be 600 mt, enough to satisfy the anticipated bycatch needs of other trawl fisheries, principally those for Pacific cod, rockfish and pollock.

Introduction

Atka mackerel (*Pleurogrammus monopterygius*) are distributed from the east coast of the Kamchatka peninsula, throughout the Komandorskiye and Aleutian Islands, north to the Pribilof Islands in the eastern Bering Sea, and eastward through the Gulf of Alaska to southeast Alaska. Their center of abundance according to past surveys has been in the Aleutian Islands, particularly from Buldir Island to Seguam Pass. Gulf of Alaska (GOA) Atka mackerel are managed as a gulfwide species and managed separately from the Bering Sea/Aleutian Islands.

An Atka mackerel population existed in the Gulf of Alaska primarily in the Kodiak, Chirikof, and Shumagin areas, and supported a large foreign fishery through the early 1980s. By the mid-1980s, this fishery, and presumably the population, had all but disappeared. Evidence of the low population levels was supported by Atka mackerel bycatch in other fisheries of less than 5 mt prior to 1988. The decline of the GOA Atka mackerel fishery suggests that the area may be the edge of the species' range. During periods of high recruitment in the Aleutian Islands, it is thought that juvenile Atka mackerel may move into the GOA under favorable conditions (Ronholt 1989). Recently, Atka mackerel have been detected by the summer trawl surveys primarily in the Shumagin (Western) area of the Gulf of Alaska.

Very little is known about the biology and ecology of Atka mackerel, and in particular, the life history of young Atka mackerel prior to their appearance in trawl surveys and the fishery at about age 2-3 years. The earliest accounts of their spawning and nesting behavior by Turner (1886) were probably erroneous. He described spawning Atka mackerel from above water as forming several strata with the least mature fish in the top layer and the spawning "vigorous males and females" in the bottom stratum. He reported that females deposit eggs on kelp and that both sexes remain until the spawning season ends in late July. This conflicts with later accounts by Gorbunova (1962) and Zolotov (1993) who used trawling, seining, and hook-and-line for collecting specimens and scuba diving for making direct observations of nesting behavior in Kamchatkan waters. Based on trawl and seine work, they surmised a shoreward spawning migration during the May-June period. Other American observers have also made note of large aggregations of Atka mackerel in coastal regions in Alaska during the summer months (Turner 1986, Bean 1887, Tanner 1890), but it is unknown whether these surface aggregations related to spawning or feeding behavior.

In Kamchatkan waters, spawning and nest guarding was reported to occur as shallow as 10 m (Gorbunova 1962) and as deep as 32 m (Zolotov 1993). Bottom type, depth, and temperature along with moderate tidal current were important factors for a nesting site. Spawning began in late June and adhesive eggs were laid in rock crevices and among stones. Marking the end of the spawning and nesting season was an absence of guardian males caught via hook and line (Zolotov 1993), and the presence of spent females in trawl catches (Gorbunova 1962). Coinciding with the end of spawning and nesting was an offshore movement of adults into deeper water, again surmised by what was seen in trawl, seine catches, and hook-and-line catches.

The first *in situ* observation of a nesting site in the U.S. Exclusive Economic Zone (EEZ) was in August 1999 off Seguam Island in the Aleutian Archipelago. Male Atka mackerel have been returning to this nesting site each year since it was first observed. Physical characteristics of the environment were similar to those reported in Gorbunova (1962) and Zolotov (1993). Clutches of eggs were found at depths ranging from 15 to 32 m. Nesting males were golden yellow with black vertical bands and they hovered close to a nest that covered an area approximately 4 m^2. Males aggregated within the nesting area and neighboring males and nests were contiguous throughout the site.

An underwater towed camera was used for subsequent investigations of Atka mackerel nesting sites during the spawning season. Camera drops were made in offshore areas and in island passes across the Aleutian Archipelago, from Attu Island to Umnak Pass. Aggregations of males were documented exhibiting exactly the same dispersal patterns, sexually dichromatic color patterns, and nesting behaviors as those males observed with *in situ* cameras at the nearshore nesting site at Seguam Island. Schools of gravid females were frequently seen either passing through these nesting areas or on the fringes. Bottom depths for these later sites extended to 100 m, far greater than those previously documented as the lower depth limit for Atka mackerel spawning and nesting. Sites below 100 m have not been explored so it is unknown if spawning and nesting extends even deeper. Indirect evidence from cannibalized eggs (Yang 1996) and archival tags (Dan Nichol AFSC pers. comm.) suggest there may be nests as deep as 180 m.

If in fact Atka mackerel are spawning over most of their depth range, the paradigm that there is an annual shoreward spawning migration may be incorrect. Recent tag recapture information from Alaska suggests that Atka mackerel populations are localized and do not travel long distances (FIT reference). Furthermore, sexually mature males and females are routinely caught in trawl hauls during the spawning season from depths below 100 m, indicating that spawning and nesting may be occurring offshore in trawlable areas. An alternative description for this annual spawning phenomenon may be that males segregate from females and disperse to areas with suitable nesting habitat, which are not necessarily exclusive to the nearshore regions.

Another difference between studies from Alaska and the Kamchatka Peninsula is the timing and duration of the nesting season. An underwater time-lapse camera was used to determine that male Atka mackerel nesters first appeared at the nearshore Seguam Island nesting site in mid-June. Males were still present when the time-lapse camera was removed on August 31st. Samples of eggs from various clutches and nests were taken and many were in the early stages of development. A freshly laid clutch of eggs collected from a nest in early August was incubated in the laboratory at 6 °C, the same temperature present at the nesting site. Time till hatching was 75-80 days. This is almost twice as long as the 40-45 days reported in the literature. Studies of ovarian condition of Atka mackerel from Alaska indicate that females continue spawning through October (McDermott and Lowe 1997). If clutches are being deposited in October, and males guard nests until hatching, it is conceivable that some males are staying on nests through December. The 4 month spawning period and 6 month nesting period are more protracted than what was observed in the western Pacific Ocean (Gorbunova 1962; Zolotov 1993).

Nichol and Somerton (2002) examined the diurnal vertical migrations of Atka mackerel using archival tags and related these movements to light intensity and current velocity. Atka mackerel displayed strong diel behavior, with vertical movements away from the bottom occurring almost exclusively during daylight hours and little to no movement at night (where they were closely associated with the bottom).

The diets of commercially important groundfish species in the Gulf of Alaska during the summer of 1990 were analyzed by Yang (1993). Atka mackerel were not sampled as a predator species. However, it can be inferred that the major prey items of Gulf of Alaska Atka mackerel would likely be euphausiids and copepods as found in Aleutian Islands Atka mackerel (Yang, 1996). The abundance of Atka mackerel in the Gulf of Alaska is much lower compared to the Aleutian Islands. Atka mackerel only showed up as a minor component in the diet of arrowtooth flounder in the Gulf of Alaska (Yang, 1993). Adult Atka mackerel in the Aleutians are consumed by a variety of piscivores, including groundfish (e.g., Pacific cod and arrowtooth flounder, Livingston et al., unpubl. manuscr.), marine mammals (e.g., northern fur seals and Steller sea lions, Kajimura 1984, NMFS 1995), and seabirds (e.g., tufted puffins, Byrd et al. 1992).

A morphological and meristic study suggested that there may be separate populations in the Gulf of Alaska and the Aleutian Islands (Levada 1979). This study was based on comparisons of samples collected off Kodiak Island in the central Gulf, and the Rat Islands in the Aleutians. Lee (1985) also conducted a morphological study of Atka mackerel from the Bering Sea, Aleutian Islands and Gulf of Alaska. The data showed some differences (although not consistent by area for each characteristic analyzed), suggesting a certain degree of reproductive isolation. However, results from a genetics study comparing Atka mackerel samples from the western Gulf of Alaska with samples from the Eastern, Central, and Western Aleutians showed no evidence of discrete stocks (Lowe et al. 1998). Between-sample variation was extremely low among the four samples indicating a large amount of gene flow is occurring throughout the range. It is presumed that gene flow is occurring during the larval, pelagic stage, particularly in the Aleutian portion of their range, and that the localized aggregations reflect the distribution of surviving, settled larvae and juveniles. Differences in growth rates consistently observed throughout their Alaskan range are believed to be phenotypic characteristics reflecting differences in the local environment. Further genetic studies are currently underway using microsatellite DNA to evaluate the genetic structuring in Atka mackerel

While genetic information suggests that the Aleutian Island (AI) and Gulf of Alaska (GOA) populations of Atka mackerel could be managed as a unit stock, there are significant differences in population size, distribution, recruitment patterns, and resilience to fishing that suggest otherwise. Bottom trawl surveys and fishery data suggest that the Atka mackerel population in the GOA is smaller and much more patchily distributed than that in the AI, and composed almost entirely of fish > 30 cm in length. There are also more areas of moderate Atka mackerel density in the AI than in the GOA. The lack of small fish in the GOA suggests that Atka mackerel recruit to that region differently than in the AI, perhaps as juveniles moving east from the larger population in the AI rather than from larval settlement in the area. This might also explain the greater sensitivity to fishing depletion in the GOA as shown by both the history of the GOA fishery since the early 1970s and Leslie depletion estimates of catchability (Lowe and Fritz 1996). Catches of Atka mackerel from the GOA peaked in 1975 at about 27,000 mt. Recruitment to the AI population was low from 1980-1985, and catches in the GOA declined to 0 in 1986. Only after a series of large year classes recruited to the AI region in the late 1980s did the population and fishery reestablish in the GOA beginning in the early 1990s. After passage of these year classes through the population, the GOA population, as sampled in the 1999 GOA bottom trawl survey, has declined and is very patchy in its distribution. Leslie depletion analyses using AI and GOA fishery data suggest that catchability increased from one year to the next in the GOA fished areas, but remained the same in the AI areas. These differences in population resilience, size, distribution, and recruitment argue for separate management of GOA and AI stocks despite their genetic similarities.

Fishery

Catch History and Fishery Management

Prior to the mid-1980s, Atka mackerel were fished exclusively by foreign vessels, primarily from the Soviet Union. Landings peaked at 27,777 mt in 1975, then dropped to almost 0 in 1986 (see GOA SAFE Table 5). Some joint venture operations participated in this fishery from 1983 to 1985. All landings since then have been taken by the domestic fishery.

In 1988, Atka mackerel were combined in the other species category due to low abundance and the absence of a directed fishery for the previous several years. However, beginning in 1990, Atka mackerel were targeted in the western Gulf of Alaska (GOA). From 1990-1993, catches of other species in the GOA were dominated by Atka mackerel, primarily from the Western regulatory area. Atka mackerel were separated from the other species category and became a separate target category in the GOA in 1994 after approval of Amendment 31 to the Fishery Management Plan for the Groundfish Fishery of the Gulf of Alaska. Recent catches of Atka mackerel from the GOA have been:

Gulf of Alaska (GOA) Catches (mt) by Management Areas

Year	Western	Central	Eastern	Total
1990[a]	1,416	0	0	1,416
1991	3,249	9	0	3,258
1992	13,785	49	0	13,834
1993	4,867	2,143	0	7,010
1994	2,661	877	0	3,538
1995	329	370	2	701
1996	1,577	9	0	1,586
1997	321	8	2	331
1998	279	38	0	317
1999[b]	-	-	-	262
2000	-	-	-	170
2001	-	-	-	76
2002	-	-	-	85
2003[c]	-	-	-	565

a/ Actual observed catch
b/ TAC is set GOA-wide; catches not available by regulatory area
c/ NMFS Bulletin Board as of 11/01/03

Total catches of Atka mackerel were small until 1992, when approximately 14,000 mt were taken in the Shumagin area. The 1990 catch of 1,416 mt is a minimum estimate, since this was the tonnage actually observed by domestic observers. The Alaska Regional Office's estimate of catch for 1990 is underestimated, as Gulf of Alaska Atka mackerel catches were incorrectly being reported as landed in the Aleutian Islands (pers. comm. Galen Tromble, Regional Office, Juneau, Alaska). For 1995 and 1996, the Council approved an ABC and a TAC of 3,240 mt for Gulf of Alaska Atka mackerel. For purposes of data collection and effort dispersion, 2,310 mt was allocated to the Western or Shumagin subarea (Area 610) and 925 mt was allocated to the Central, or the combined Chirikof and Kodiak subareas (Areas 620 and 630). The Western subarea (610) was not opened to the directed Atka mackerel fishery in 1995 because the overfishing level for Pacific ocean perch (POP) was nearly reached; Atka mackerel fisheries have had significant bycatch of POP (A. Smoker, NMFS, Juneau, AK, pers. comm.). In 1996, the fishery in the Western subarea was restricted to a 12-h opening on July 1, due again to concerns about the POP catch exceeding TAC and approaching the overfishing level; about 1,600 mt of Atka mackerel were caught. The 1996 Central POP catch exceeded the Central area POP overfishing level, thus there was no opening for the Atka mackerel fishery in that area. Since 1997 the Atka mackerel fishery has been managed as a bycatch-only fishery with TACs of 1,000 mt in 1997 and 600 mt for the years 1998 to 2003.

The catch of GOA Atka mackerel jumped dramatically in 2003. As of November 1, 2003, catches had reached 565 mt. This coincides with local sports fishermen reporting catching Atka mackerel for the first time off Resurrection Bay and as far as Southeast Alaska in 2003. Two strong back-to-back year classes (1998 & 1999) have shown up prominently in the Aleutian Islands (Lowe et al. 2003), and the Gulf of Alaska Atka mackerel may be 4-year olds from the 1999 year class as indicated by the 2003 survey data (see Survey Age Frequencies section below).

Figure 13.1 shows the 2003 distribution of observed catches of Atka mackerel in the Gulf of Alaska summed by 20 km areas. Most of these catches occurred during July through October. Open circles represent observed catches greater than 1 mt. Large catches were observed in Unimak Pass, and in the Shumagin and Chirikof areas. Many of these large catches were retained. It is apparent that in 2003, fishermen were encountering large enough quantities to allow for some targeting of Atka mackerel. The small closed circles represent observed catches less than 1 mt and probably represent true bycatch. It is notable that observations of small catches of Atka mackerel in 2003 extended well into the Kodiak area.

Scientific research catches are reported in the SAFE reports. Table 13.1 documents annual research catches (1977 - 1998) from NMFS trawl surveys.

Description of the Directed Fishery

There has not been a directed fishery for Atka mackerel since 1997. A discussion of the directed fishery for the years 1990-1994 is given in Lowe and Fritz (2001). However, there appears to be some targeting of Atka mackerel in the Western and Central Gulf of Alaska in 2003 (see discussion above).

Bycatch and Discards

Discussion of the historical amount of Atka mackerel retained and discarded by target fishery and area in the Gulf of Alaska in 1994 and 1995 have been given in previous assessments (Lowe and Fritz, 2000 and Lowe and Fritz 2001). Blend data for 2003 is not available so the amount of Atka mackerel retained and discarded by target fishery and area could not be readily provided. However, a preliminary analysis of the 2003 observer data showed that most of the Atka mackerel bycatch in the Shumagin and Chirikof areas was taken in the trawl rockfish fisheries. The database also indicated that pollock boats in Unimak Pass were encountering large amounts of Atka mackerel bycatch and there appears to have been targeted fishing on Atka mackerel.

Fishery Length Frequencies

Atka mackerel length distributions from the 1990-1994 fisheries are discussed in previous assessments (Lowe and Fritz 2001). In 2003 observers were able to take length frequency measurements of nearly 1,400 Atka mackerel in the Shumagin area (Figure 13.2). The distribution of fish is mainly between 35 and 45 cm with a mode at 38 cm.

Fishery Sex Ratios

In certain areas and months, historical catches of Atka mackerel were comprised of more females than males (Lowe and Fritz 2001). Differential sex ratios in the historical fisheries could be a result of segregation of the population by sex during spawning and periods of male nest-guarding in summer and early fall. This suggests differential habitat utilization by Atka mackerel in areas frequented by the fishery in the Gulf of Alaska, and has also observed between areas in the Aleutian Islands (Fritz and Lowe 1998). The Atka mackerel sampled in the 2003 fisheries (Figure 13.2) were comprised of nearly equal numbers of males and females.

Fishery Age Frequencies

There is only very limited age data available from the 1990 Davidson Bank fishery, the 1992 Umnak Island fishery and the 1994 fishery which operated off Umnak Island, Davidson Bank and Shumagin Bank. These data are discussed in Lowe and Fritz (2001).

Fishery and Steller Sea Lions

The western stock of Steller sea lions, which ranges from Cape Suckling (at 144°W) west through the Aleutian Islands and into Russia, is currently listed as endangered under the Endangered Species Act, and has been listed as threatened since 1990. In 1991-92, 10 nm annual trawl exclusion zones were established around all rookeries west of 150°W; in 1992-93, 20 nm trawl exclusion zones were established around 6 rookeries in the eastern Aleutian Islands that are operational only during the BSAI pollock A-season. In 1993, NMFS designated Steller sea lion critical habitat, which includes a 20 nm aquatic zone around all rookeries and major haulouts west of 144°W, and three foraging areas, one of which contains Shelikof Strait. Sea lion food habits data collected in the Aleutian Islands revealed that Atka mackerel was the most common prey of Steller sea lions throughout the year (NMFS 1995, Sinclair and Zeppelin 2002).

From 1977 to 1984 and in 1990, 0-11% of the annual Gulf of Alaska Atka mackerel harvest was caught within 20 miles of all Gulf of Alaska sea lion rookeries and major haulouts, reflecting the offshore distribution of the fishery. In 1991-93, however, the fishery moved closer to shore, and this percentage increased to 82-98%, almost all of which was caught between 10-20 nm of Steller sea lion rookeries on Ogchul and Adugak Islands (near Umnak Island), and Atkins and Chernabura Islands in the Shumagin Islands.

Leslie depletion estimates of local fishery harvest rates were much greater than estimated Gulf-wide harvest rates (Lowe and Fritz 1996; 1997). This could have adversely affected Steller sea lion foraging success, which raised concerns about how the fishery may have affected food availability and the potential for recovery of the Steller sea lion population. There has not been a directed Gulf of Alaska Atka mackerel fishery since 1996. In June 1998, the Council passed a fishery regulatory amendment which proposed a four-year timetable to temporally and spatially disperse and reduce the level of Atka mackerel fishing within Steller sea lion critical habitat in the Bering Sea/Aleutian Islands. The regulations implementing this four-year phased-in change to Atka mackerel fishery management became effective on 22 January 1999 and lasted only 3 years (through 2001). In 2002, new regulations affecting management of the Atka mackerel, pollock, and Pacific cod fisheries went into effect. The management of the Bering Sea/Aleutian Islands Atka mackerel fishery is detailed in Lowe et al. (2003).

Data

Absolute Abundance and Survey Biomass

Bottom trawl surveys of the Gulf of Alaska groundfish community have been conducted every three years since 1984 and biennially since 1999 using an area-depth stratified and area-swept design. In 1999, the same GOA survey design was maintained, but effort allocation was shifted to provide more even coverage within depth strata. Atka mackerel are a very difficult species to survey because: (1) they do not have a swim bladder, making them poor targets for hydroacoustic surveys; (2) they prefer hard, rough and rocky bottom which makes sampling with the standard survey bottom trawl gear difficult; and (3) their schooling behavior and patchy distribution makes the species susceptible to large variances in catches which greatly affect area-swept estimates of biomass.

The general groundfish surveys of the Gulf of Alaska are particularly problematic for Atka mackerel given the characteristics described above. In 1996, a meaningful estimate of biomass could not be determined from the data due to extreme variances. Over 98% of the Atka mackerel caught in the 1996 survey were encountered in a single haul within a large stratum, which yielded a large stratum biomass with an extremely large confidence interval.

Although estimates of abundance from earlier surveys have been presented in previous assessments, they were also compromised by the problem of large confidence intervals, although not to the same degree as observed in 1996. Similar to the 1996 survey, virtually all the GOA Atka mackerel biomass from the 2001 survey was encountered in a single haul south of the Islands of Four Mountains. Atka mackerel have been inconsistently caught in the GOA surveys, appearing in 5%, 28%, 12%, 20%, 10% and 35% of the hauls in the Shumagin area in the 1990, 1993, 1996, 1999, 2001 and 2003 GOA surveys, respectively. What can be concluded from this is that the general groundfish GOA bottom trawl survey, as it has been designed and used since 1984, does not assess Atka mackerel well and the resulting biomass estimates are not considered reliable indicators of absolute abundance or as indices of trend.

It is interesting to note that the 2003 survey encountered the highest percentage of hauls with Atka mackerel catch since 1990. Catches were less patchy relative to previous surveys, and observations extended into the Central Gulf of Alaska. This is coincident with dramatically increased catches of Atka mackerel in the fishery, and reports from local sports fishermen of catches of Atka mackerel in the Central Gulf and even off Southeast Alaska.

Given the problems with assessing GOA Atka mackerel with the bottom trawl survey, there is no reliable estimate of current biomass of Atka mackerel in the GOA. The only indicator of historical trends in abundance comes from analyses of catch-per-unit-effort of the 1992-94 directed Atka mackerel fisheries south of Umnak Island and southeast of the Shumagin Islands which are detailed in the BSAI assessment (Lowe and Fritz 1997) and in the appendix of the 1996 GOA assessment (Lowe and Fritz 1996). These analyses suggest that the Umnak Island Atka mackerel population declined 81% between 1992 and 1994, while the Shumagin Island population declined 58%.

Survey Length Frequencies

Length frequency distributions from the 1996, 1999, and 2001 surveys are shown in Figure 13.3. Mean lengths of males and females, respectively, from each survey are: 45.4 and 47.0 cm in 1996, 45.4 and 46.8 cm in 1999, and 41.6 and 44.3 cm in 2001.

It is interesting to note that the length frequency distributions of males and females differ in the GOA surveys. The female length frequency distributions show a greater proportion of large fish, while the male distributions show greater proportions of small fish (Figure 13.3). This has not been observed in the Aleutian Islands surveys; the male and female length frequency distributions are not differentiable and survey length frequency distributions are presented for combined sexes (Lowe et al. 2003).

The length frequency distributions from the 2003 Gulf of Alaska survey from the Shumagin, Chirikof, and Kodiak areas are shown in Figure 13.4. The distributions of fish from the survey fall mainly between 35 and 45 cm, with modes at 38-41 cm, very similar to the 2003 fishery length frequency data (Figure 13.2). The distributions of male and female fish in the Shumagin and Chirikof areas are very similar with females showing a slightly greater proportion of large fish, whereas as the distributions in the Kodiak differ more so, with females showing a distinctly greater proportion of large fish (Figure 13.4).

Survey Age Frequencies

Historical survey age data from the Gulf of Alaska trawl survey are only available from 1993 (Figure 10.11 in Lowe and Fritz 2001). The 1993 survey showed a mode of 5-year olds from the 1988 year class which has also been documented as a strong year class in the Aleutian Islands (Lowe et al. 2003).

The 2003 Gulf of Alaska survey was able to sample a large amount of Atka mackerel, and 482 otoliths were aged (Figure 13.5). The 2003 age data show that the survey catches were comprised mainly of 4-year-olds from the 1999 year class (63%), followed by significant numbers of 5-year-olds from the 1998 year class (20%). The 1998 and 1999 year classes are documented to be well above average in the Aleutian Islands assessment (Lowe et al. 2003). The survey data indicted average lengths of the 4 and 5-year-old fish of 38 and 41-42 cm respectively. The 2003 fishery length frequency data are also dominated by fish 38-40 cm; it may be inferred that these fish are 4-year-olds from the 1999 year class.

Biological Parameters

Natural Mortality, Age of Recruitment, and Maximum Age

A natural mortality rate of 0.3 is assumed for Gulf of Alaska Atka mackerel based on Aleutian Islands Atka mackerel (Lowe et al. 2003).

A qualitative look at the sparse GOA fishery age data shows recruitment patterns similar to the Aleutian Islands fishery. The age of first recruitment appears to be 2 years, and full recruitment at 4 years (Lowe and Fritz 2001). This pattern becomes somewhat obscured when a strong year class dominates the distributions.

The maximum age seen in the Gulf of Alaska fishery is 13 years (1990 fishery). This compares with a maximum age of 15 years for the Aleutian Islands.

Length and Weight at Age

Parameters of the von Bertalanffy length-age equation and a weight-length relationship were calculated from the combined 1990, 1992, and 1994 fishery data. Sexes were combined to provide an adequate sample size. The estimated von Bertalanffy growth parameters are:

L_∞ = 54.56 cm
K = 0.22
t_0 = -2.78 yr

Length-age equation: Length (cm) = $L_\infty\{1\text{-exp}[-K(\text{age-} t_0)]\}$.

The weight-length relationship was determined to be:

Weight (kg) = 4.61E-05*Length (cm) 2.698

Growth parameters were also estimated from data collected during the 1993 Gulf of Alaska survey. As in the Aleutians, the survey tends to select for smaller fish at age than the fishery. The estimated von Bertalanffy parameters from the 1993 survey are:

L_∞ = 47.27 cm
K = 0.610
t_0 = 0.38 yr

and the estimated weight-length relationship is:

Weight (kg) = 1.55E-05*Length (cm) 2.979.

Further analyses of the 2003 survey and fishery age, length and weight data are planned and comparisons will be made with historical data.

The age-length and weight-length schedules for the fishery and survey are given in Table 13.2.

Maturity at Length and Age

Female maturity at length and age were determined for Gulf of Alaska Atka mackerel (McDermott and Lowe 1997). The maturity schedules are given in Table 13.3. The age at 50% maturity is 3.6 years and length at 50% maturity is 38.3 cm.

Selectivity at Age

The small amount of age data for Gulf of Alaska Atka mackerel show similar selectivity patterns as seen in the Aleutian survey and fishery data. The fishery data tend to show older fish than the survey samples. The oldest age from the 1993 survey was 9 years old and the age distribution consisted of mostly 2-6 year olds (Lowe and Fritz 2001).

Overfishing Level and Acceptable Biological Catch

There is no reliable estimate of current Atka mackerel biomass in the Gulf of Alaska. In this situation, Tier 6 of Amendment 56 of the BSAI FMP defines the overfishing level (OFL) as the average catch from 1978-95, and the ABC cannot exceed 75% of the OFL. The average annual catch from 1978-95 is **6,200 mt, which is the overfishing level.**

The ABC is capped at 6,200 x 0.75 = 4,700 mt. However, we recommend that ABC be set lower than 4,700 mt for the following reasons:

1. When ABCs were lower than 4,700 mt, such as in 1994 when the ABC was 3,280 mt, the fishery may have created localized depletions of Atka mackerel in the two primary fished areas, south of Umnak Island and southeast of the Shumagin Islands (see appendix in Lowe and Fritz 1996). The 1994 ABC was set using a 15% harvest rate applied to the 1993 survey biomass estimate of 21,600 mt. The two

1994 fisheries at Umnak and Shumagin combined for over 3,000 mt of the 3,500 mt caught that year, and harvest rates far exceeded the target 15% in each area: at Umnak, the harvest rate was estimated at 85%, and at Shumagin, the harvest rate was estimated at 91%. The 1990 and 1993 surveys also found that Atka mackerel in the GOA were principally congregated in these two areas used by the fishery. These data indicate that the fishery was very efficient in removing fish from these areas and at rates which far surpassed the target Gulf-wide harvest rate.

2. Analyses of local fishery CPUEs suggests that the Atka mackerel populations at Umnak and Shumagin Islands declined significantly between 1992 and 1994 (see appendix in Lowe and Fritz 1996). This also reflects the trend of the Aleutian Island Atka mackerel population during that period.

3. The GOA Atka mackerel population appears to be particularly vulnerable to fishing pressure because of its very patchy distribution and sporadic recruitment patterns. This is reflected in the Leslie depletion analyses (appendix in Lowe and Fritz 1996) and by the disappearance of the population in the mid-1980s following a period with annual catches as high as 27,000 mt.

4. Although there has been a dramatic increase in the observations of Atka mackerel in the 2003 fishery and survey, these catches appear to be comprised of basically a single year class (1999 year class) which has been documented as well above average in the Aleutians (Lowe et al. 2003). As this is the first appearance of this year class, speculation is that this is overflow from the Aleutian population.

For the above reasons, we continue to recommend a 2004 ABC for GOA Atka mackerel sufficient to satisfy the bycatch needs of other trawl fisheries, a recommendation identical to that made since 1997. Catches of Atka mackerel in the GOA in 1997, 1998, 1999, 2000 and 2001 were only 331, 291, 316, 170, and 76 mt, respectively, which could represent the natural bycatch of Atka mackerel in other groundfish fisheries. The catch in 2003 is 565 mt which does appear to include some targeted catches. However, this level of catch (< 600 mt) is still considered to be a reasonable amount to allow for bycatch and minimize targeting. **We recommend a 2004 GOA Atka mackerel ABC of 600 mt**.

Ecosystem Considerations

The Western stock of the Steller sea lion (*Eumetopias jubatus*) is currently listed as endangered under the Endangered Species Act. It was originally listed as threatened in 1990 following a 70% decline in abundance throughout its Alaskan range since the mid-1970s and steep declines (15% per year) between 1985-1989. Since 1990, the number of sea lions in the western stock has declined at approximately 5% per year, and throughout most of its range in Alaska, the decline may have halted between 2000 and 2003. However, the sea lion population in the western Aleutian Islands (all of area 543 and the western part of 542) continues to decline in both non-pup and pup numbers (Sease and Gudmondson 2002). It is not known why declines may have recently abated in part of the range of the western stock, while not in others

As a result of the listing, trawling was prohibited within 10 nautical miles (nm) of all rookeries in the Central and Western Gulf of Alaska year-round beginning in June 1991; 10 nm no-trawl buffer zones were created around all other Steller sea lion rookeries in the Aleutian Islands and Bering Sea in January 1992. The intent of this action was to exclude trawl fishing activity from areas known to be important for sea lion foraging and reproduction. While there is no proven cause and effect relationship between the decline in Steller sea lion numbers and increases in fishery removals near terrestrial sea lion habitats, NMFS imposed the 10 nm trawl exclusion zones based on general conservation principles in an effort to promote sea lion recovery. Aerial surveys conducted through 1996 revealed that the Steller sea lion population in the western GOA has been relatively stable since 1989, but at about 50% of the size that existed prior to the decline (mid-1970s). This is in contrast to the central GOA, where the sea lion population has declined over 80% in the same period, and continued to decline at about 10% per year (NMFS 1995).

Steller sea lion food habits data (from analysis of scats) from the Aleutian Islands indicate that Atka mackerel is the most common prey item throughout the year (NMFS 1995, Sinclair and Zeppelin 2002). The prevalence of Atka mackerel and walleye pollock in sea lion scats reflected the distributions of each fish species in the Aleutian Islands region. The percentage occurrence of Atka mackerel was progressively greater in samples taken in the central and western Aleutian Islands, where most of the Atka mackerel biomass in the Aleutian Islands is located. Conversely, the percentage occurrence of pollock was greatest in the eastern Aleutian Islands. Steller sea lion food habits data from the western Gulf of Alaska are relatively sparse, so it is not known how important Atka mackerel is to sea lions in this area. The close proximity of fishery locations to sea lion rookeries in the western Gulf suggests that Atka mackerel could be a prey item at least during the summer. Analyses of fishery CPUE revealed that the fishery may create temporary localized depletions of Atka mackerel, and that these depletions may last for weeks after the vessels have left the area. This supports the argument already made above in the ABC section for a conservative harvest policy for Atka mackerel in the Gulf of Alaska.

Summary

Tier 6
M = 0.30
F_{ABC}= unknown
F_{OFL}= unknown

2004 exploitable biomass	= unknown
2004 Overfishing level	= 6,200 mt
2004 ABC	= 600 mt

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Table 13.1 Research catches of Atka mackerel from NMFS surveys in the Gulf of Alaska.

Year	Research Catches (mt)
1977	0.3
1978	2.8
1979	0.4
1980	3.8
1981	35.3
1982	27
1983	0.4
1984	7.5
1985	65.7
1986	
1987	6.2
1988	
1989	
1990	2.7
1991	
1992	
1993	2.4
1994	
1995	
1996	15.1
1997	

Table 13.2 Atka mackerel age-length and weight length schedules based on parameters estimated from combined 1990, 1992 and 1994 fishery data and the 1993 survey.

	Fishery			Survey	
Age	Length	Weight	Age	Length	Weight
1	30.80719	0.478723	1	14.88563	0.048306
2	35.49792	0.701695	2	29.67393	0.37717
3	39.26232	0.920976	3	37.70916	0.770135
4	42.28333	1.124878	4	42.07511	1.06734
5	44.70774	1.307475	5	44.44735	1.256795
6	46.65338	1.466721	6	45.73631	1.368515
7	48.21478	1.602954	7	46.43667	1.431894
8	49.46785	1.717847	8	46.81721	1.467134
9	50.47345	1.813698	9	47.02398	1.486521
10	51.28047	1.893003	10	47.13632	1.497126
11	51.92811	1.9582	11	47.19737	1.502909
12	52.44786	2.01153	12	47.23053	1.506058
13	52.86497	2.054983	13	47.24856	1.50777
14	53.19971	2.090278	14	47.25835	1.508701
15	53.46834	2.118877	15	47.26367	1.509207

Table 13.3. Schedules of age and length specific maturity from McDermott and Lowe (1997).

Length (cm)	Proportion mature	Age	Proportion mature
20	0	1	0
21	0	2	0.04
22	0	3	0.22
23	0	4	0.69
24	0	5	0.94
25	0	6	0.99
26	0	7	1
27	0	8	1
28	0	9	1
29	0	10	1
30	0		
31	0.01		
32	0.01		
33	0.02		
34	0.05		
35	0.09		
36	0.17		
37	0.29		
38	0.46		
39	0.63		
40	0.78		
41	0.88		
42	0.93		
43	0.97		
44	0.98		
45	0.99		
46	1		
47	1		
48	1		
49	1		
50	1		

Figures

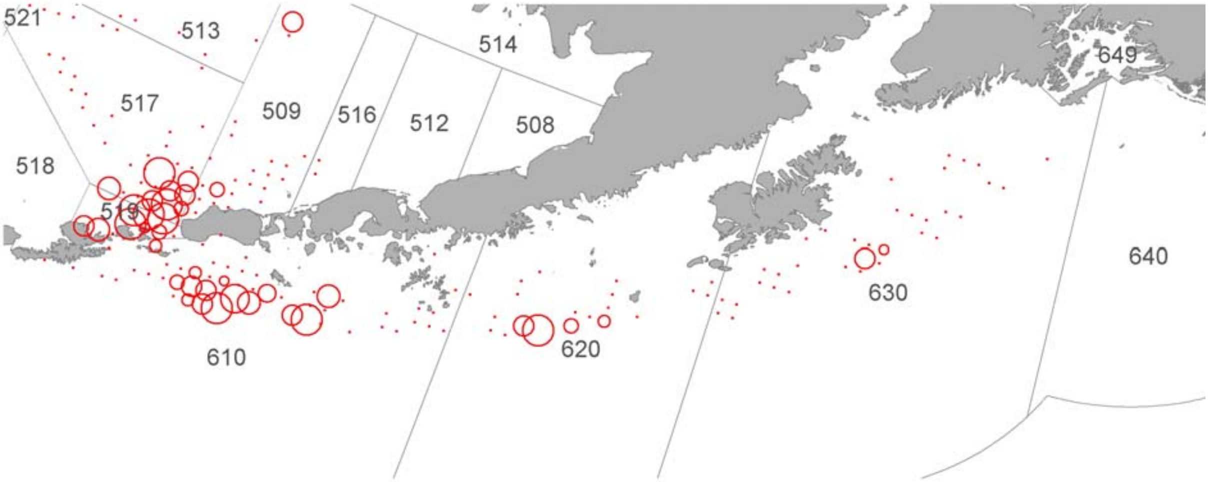

Figure 13.1. Observed catches of Atka mackerel in the 2003 fishery, summed by 20 km areas. Open circles represent catches greater than 1 mt; closed circles represent catches less than 1 mt.

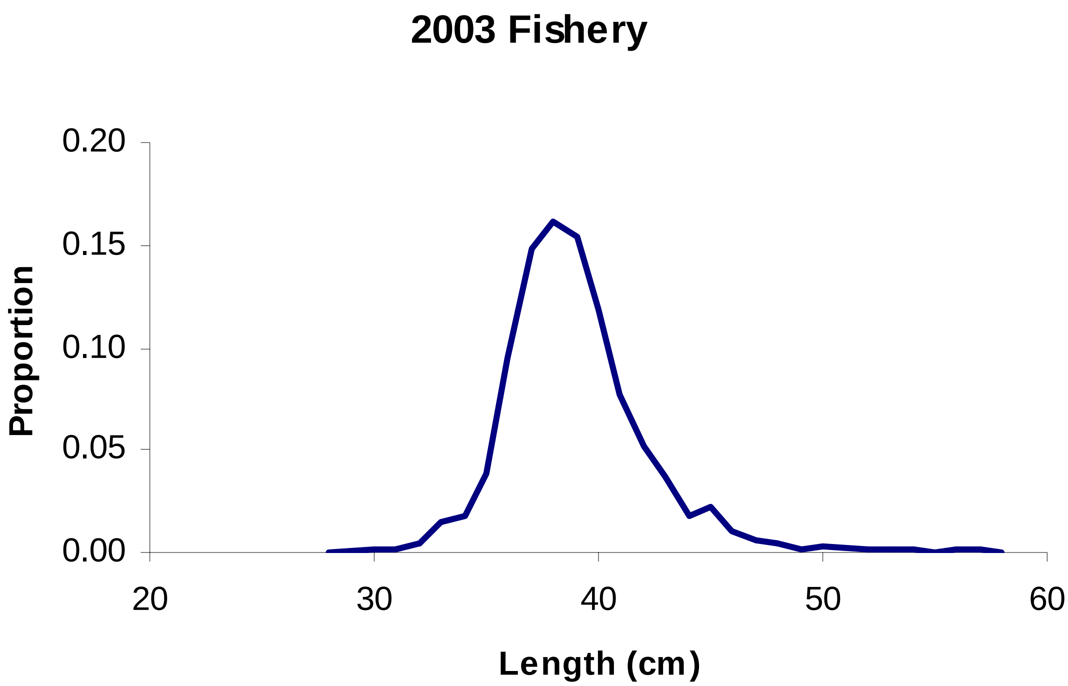

Figure 13.2. Fishery length frequency distribution of Atka mackerel for 2003 from the Shumagin area (1,380 fish were sampled).

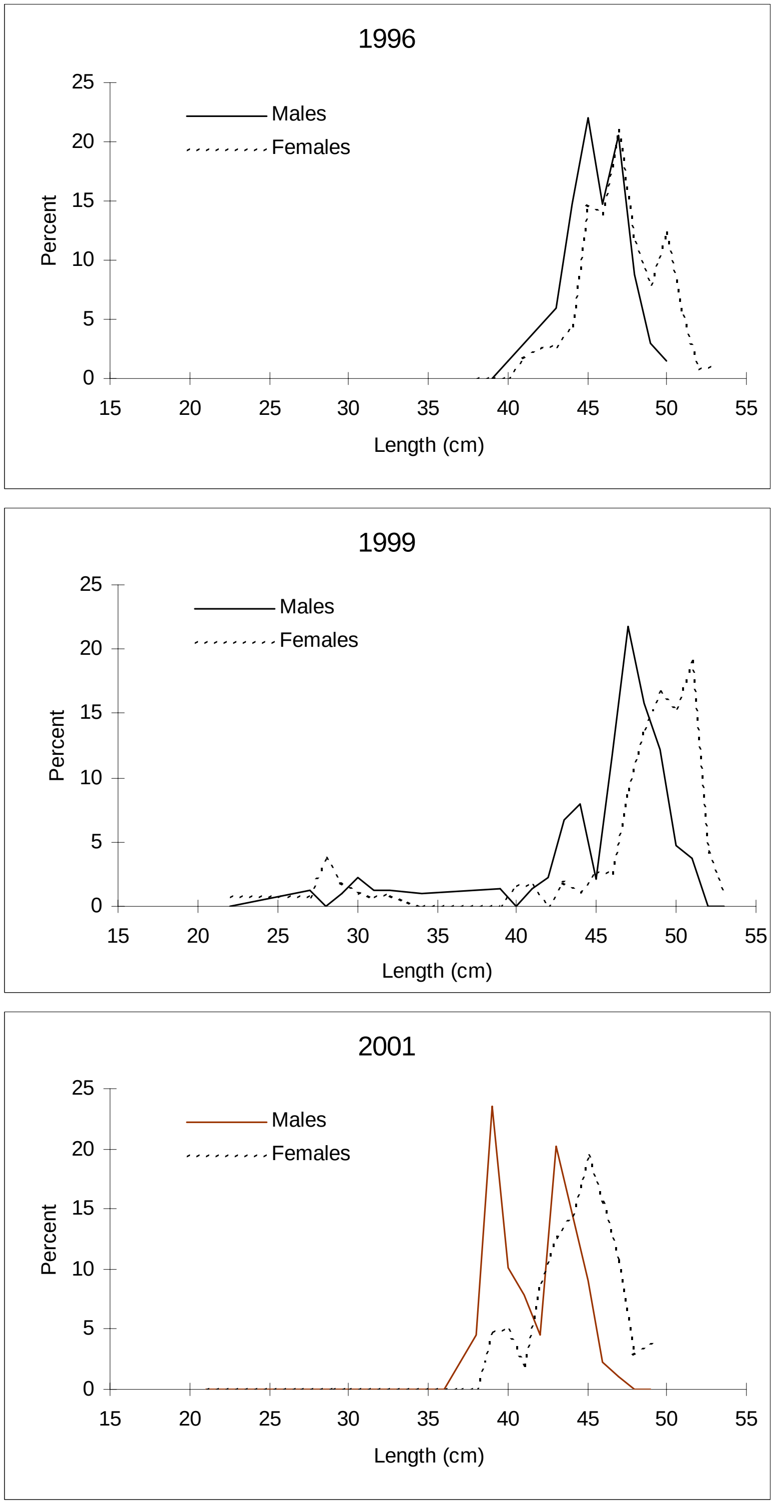

Figure 13.3. Length frequency distributions of Atka mackerel from the 1996, 1999, and 2001 Gulf of Alaska trawl surveys.

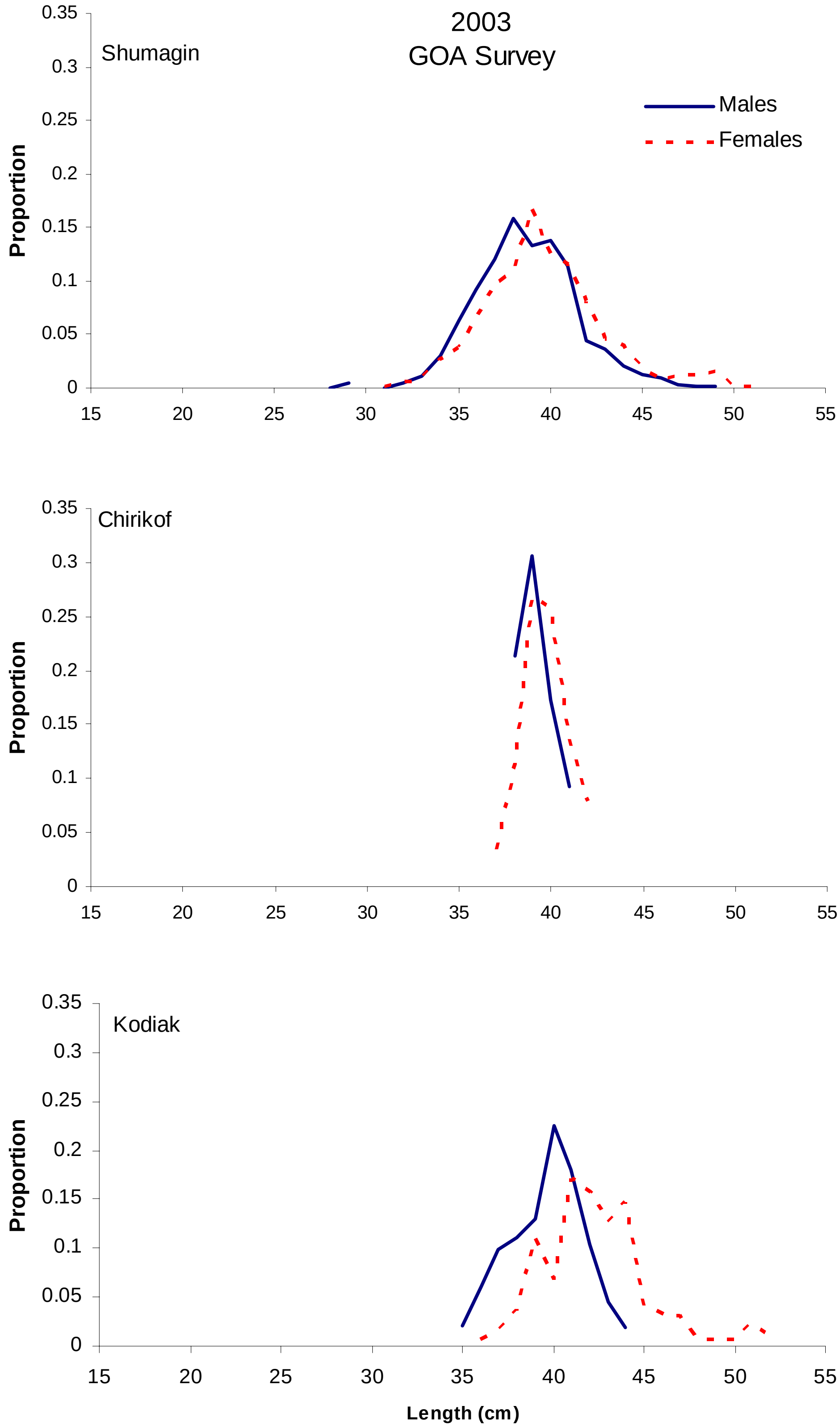

Figure 13.4 Survey length frequency distributions of Atka mackerel by region from the 2003 Gulf of Alaska trawl survey.

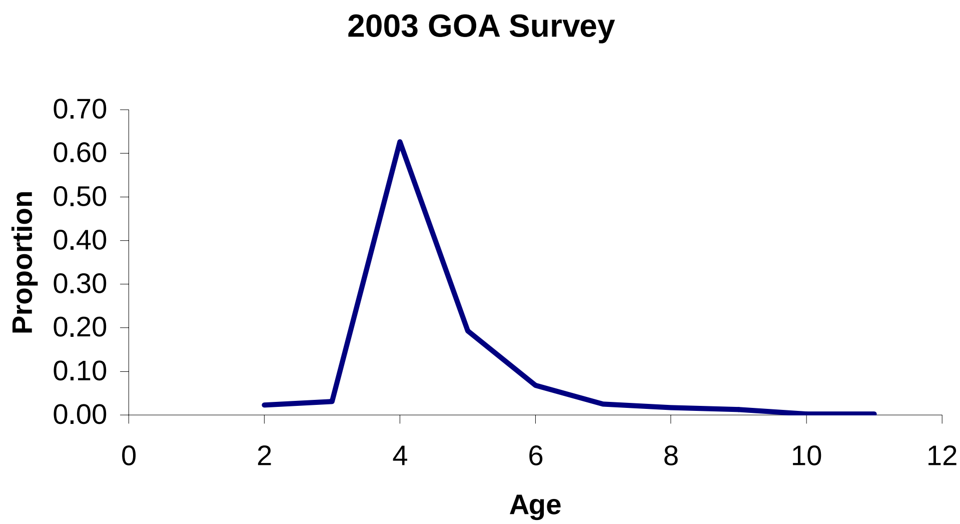

Figure 13.5 Atka mackerel age distribution from the 2003 Gulf of Alaska trawl survey (482 fish were aged).

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